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THERMODYNAMIC PROPERTIES

OF BI-METALLIC POWDERS

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Title: Thermodynamic Properties of Bi-Metallic Powders

INTRODUCTION

The object of the program is to study the heats of combustion of intermetallic compounds as compared with mechanical mixtures of the corresponding metals.

The program will consist of three parts:

1) Preparation of ultrafine powders, namely of the bimetallic alloy (compound) systems, Al B, Zr Al, Zr Si, Al Li, and Ti Si, and of the corresponding elements.
2) Determination of the heats of formation of:
   a) the above binary compounds
   b) the oxides and related products of combustion of the above binary alloys
3) The preparation of research quantities of such binary alloy powders as required for further evaluation of composition.

WORK ACCOMPLISHED AND PROBLEMS ENCOUNTERED

This report covers the work performed during the calendar quarter ending 31 December 1961.

A Parr series #1200 adiabatic calorimeter was installed, and its heat equivalent determined. A few preliminary runs on the determination of the heat of combustion of aluminum metal powder revealed that this reaction is very violent. In some cases the greater portion is ejected from the crucible and on hitting the wall of the bomb is chilled below the ignition point leading to very incomplete combustion (10%). In another case, no metal was ejected, but the reaction temperature ran up so

high that the stainless steel crucible and its support collapsed and partially burned, causing damage to the bomb. Therefore, a special combustion furnace with support was designed, as shown in Figure 1.

Initially the refractory material will consist of high purity (99%+) alumina. A number of furnace assemblies have been ordered from McDanel Refractory Porcelain Company, Beaver Falls, Pennsylvania. The platinum plate supporting the furnace has also been ordered. When experience is gained with the use of alumina, other refractory materials such as zirconia may be considered. A problem associated with the use of refractory materials is the possibility of reaction of the combustion products with the refractory materials accompanied by a heat effect.

A few runs were made to explore the field of solution calorimetry. It was found that aluminum powders are slow to react with 1 N hydrochloric acid at room temperature. Only at temperatures exceeding 55°C did reaction rates become high enough to complete the reaction in the course of minutes. Unfortunately, due to the evolution of hydrogen as well as the elevated reaction temperature, heat losses in an open reaction vessel will be excessive (of the order of 25% of the heat of reaction). A design of a solution calorimeter with a closed reaction vessel is now in progress.

Work has been started adapting the powder producing equipment for the most efficient preparation and collection of binary powders. Since some of the materials will require an electron beam as a power supply for evaporation, focusing coils

have been constructed to permit directing the evaporating metal towards the collector. Experiments have also been carried out to show that an induction heated source may be used in close proximity to an electron beam heated evaporating source. This will permit the simultaneous evaporation of two metals using the optimum evaporating technique for each. By having the sources close together, it will be possible to obtain intimate mixture of the metal vapors and thereby form the intermetallic compounds.

In order to improve the efficiency of collection of the powders produced by this technique, a cylindrical water cooled collecting drum has been constructed. This drum is mounted on a coaxial rotating drive feeding through the wall of the vacuum chamber. By using this system, it is anticipated that relatively small quantities of reactive metal powders can be collected and efficiently handled. This system will be used first for the production of bimetallic powders of aluminum and boron, both of which have been prepared individually. After these powders have been prepared the next system will be lithium aluminum.

DIFFICULTIES ENCOUNTERED

Delay in receipt of signed contract has delayed the ordering of necessary operating materials.

FUTURE WORK

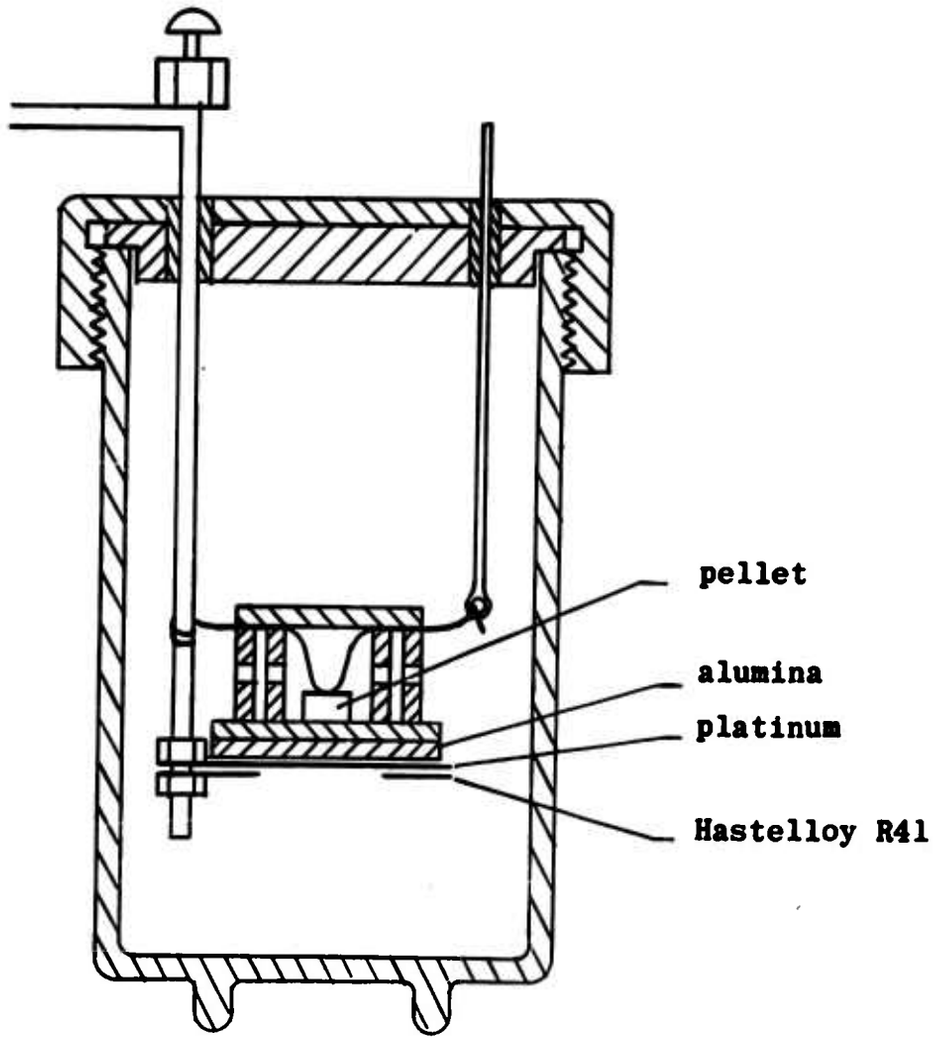
Design of a solution calorimeter will be completed and construction will be started.

Powders of the bimetallic alloy (compound) systems

Al B, Zr Al, Zr Si, Al Li, and Ti Si will be prepared as well as powders of the corresponding pure elements.

The heat of combustion of the pure metals will be determined first and then compared with the data available from the literature. Then the heats of combustion of the bimetallic alloys (compounds) will be determined.

FIGURE I



Oxygen Bomb With Refractory Furnace Assembly and Support.

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